U. S. DEPARTMENT OF COMMERCE

BUREAU OF FISHERIES

ery Circular No. 18. Issued January 1935

NDITIONS AFFECTING THE SOUTHERN WINTER TRAWL FISHERY[1]

ROBERT A. NESBIT, *Assistant Aquatic Biologist*, and WILLIAM C. NEVILLE, *Senior Biological Aide, United States Bureau of Fisheries*

CONTENTS

	Page
oduction	1
nges in summer fishery	2
nges in winter fishery	2
nges in temperature	3
p scatter in warm winters	6
bass in warmer water than scup	7
ke in more northerly part of ground	7
look for the winter of 1935 (Jan.–Mar. 1935)	9
servation problems	10

INTRODUCTION

With the opening of another season of the winter-trawl fishery the Virginia Capes, questions have been raised as to what might expected during the coming winter (Jan.–Mar. 1935). It is the sent intention to answer these questions as completely as is per- tted by the results of the Bureau's studies of the winter and sum- r fishery for scup, sea bass, and fluke, these being the three most portant fishes in the southern winter-trawl fishery. The discussion l be more complete as to scup for there is more information on t fish than on sea bass or fluke. However, much of what is said ut scup in the winter fishery generally applies to sea bass and ke since all three fishes were subject to the same conditions and re affected in about the same general way, though to differing grees.

The trawl fishery during the past four winters developed very idly since the winter of 1929.[2] The fishery has attracted vessels m many ports from Virginia to Massachusetts, the number of ts increasing from about 50 in 1931[3] to about 100 in 1934. The al catch of scup, sea bass, and fluke has risen from approximately 00,000 pounds in 1931 to approximately 8,000,000 pounds in 1934. this short period of four winters there have also occurred marked nges in the water temperatures over the general fishing area,

Approved for publication, Nov. 13, 1934.

[1] An account of this fishery is given in "Winter-trawl fishery off the Virginia and th Carolina coasts" by John C. Pearson. Investigational Report No. 10, Bureau of eries, 1932.

[2] The winter fishery takes place mainly in January, February, and March, and it is to se months reference is made when a certain year is mentioned; for instance, by 1931 eant January, February, and March of 1931.

which have been accompanied by changes in the location of fishi in the amounts of fish caught, the proportions of scup, sea bass, a fluke in the catch, and in the perplexing movements of the fish ov the general fishing area.

In attempting to find the causes of these changes in the wint fishery for scup, it is necessary to consider changes that have occurr in the summer fishery as well. Prior to 1929 the scup was genera considered a "summer fish"; that is, it was usually taken in t summertime and constituted an important product of the pound n trap, and seine fisheries which are prosecuted during the summ along the Atlantic inshore waters from Chesapeake Bay to Cape C The catch in the summer fishery still exceeds that of the wint trawl fishery but with the rapid growth of the latter, an increasi strain is being placed on this fish and the question has been rais whether or not the stock can withstand the year-around fishing which it is now subject.

It is now quite clear that the winter and summer fisheries are dra ing on the same stock of scup. As a result of tagging, it has be learned that scup migrate in the fall from the summer fishi grounds along the shores of southern New England and New Jers to the winter fishing grounds off the Virginia Capes, and in t spring make a return migration from the winter grounds to t summer area.[4] The actual releases and recaptures of marked scup a charted in figure 1. Furthermore, comparisons of the size and a of the fish in the catches of the summer and winter fisheries ha shown that broods of scup that have been present in large numbe either in the New Jersey inshore summer pound-net fishery or in t more offshore summer-trawl and seine fisheries have also been tak in considerable quantities by the southern-trawl fishery in the f lowing winters. Thus, there can be little doubt that both fisher do draw on the same general stock of scup.

CHANGES IN SUMMER FISHERY

The outstanding development in the summer fishery has been t great increase in the catch of scup along the coast of New Jers beginning in 1929 with continued high yields each subsequent su mer. The pound net catch rose from one of the lowest on reco in 1928 (316,000 pounds) to a new high level of 4,100,000 pounds 1931, and catches of about 3,600,000 pounds in 1932 and 1933. The high yields resulted from successful spawnings in 1927, 1928, 19 1931, and 1932. Inasmuch as there was no great increase in t amount of gear fished during the change from low to high yie the good catches of recent years must have been due to natu causes rather than to an increase in the amount of fishing in t summertime.

CHANGES IN WINTER FISHERY

In the winter trawl fishery, on the other hand, the increases the total catch during the past four seasons have been caused some years by increased fishing effort and in some years by i

[4] For a more detailed account of the results of summer and winter tagging exp ments, see "Will the winter fishing off Virginia ruin the industry?" by W. C. Nev Fishing Gazette, vol. 50, no. 6, June 1933.

eased availability to the gear, the latter being connected with anges in water temperatures. It is not surprising to find that difrence in water temperature should affect the movements and bevior of fish in the winter trawl fishing area since it probably is mperature that causes the fish to leave their summer grounds with e chilling of the inshore waters in the fall and to migrate to inter regions where temperatures are at least as high as the lowest

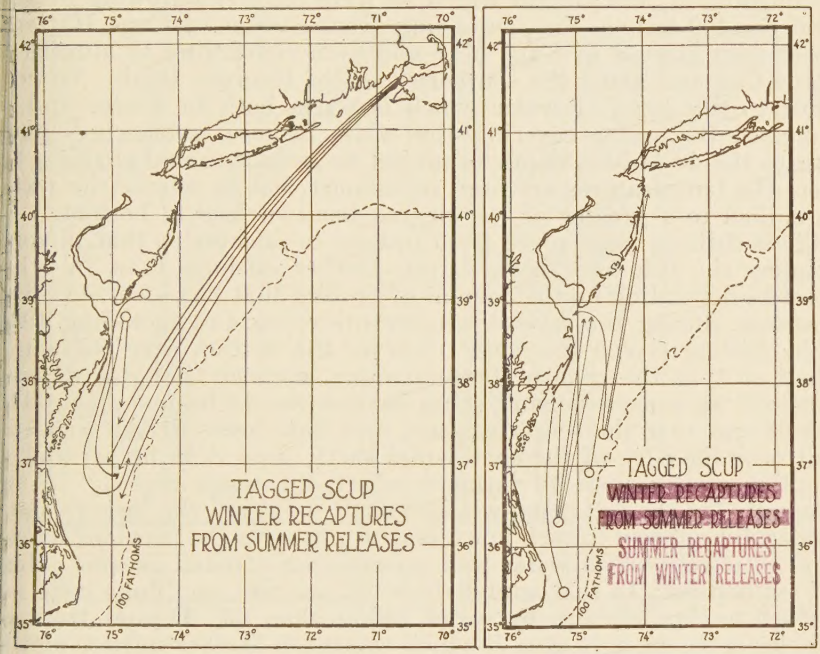

FIGURE 1.—Recaptures of tagged scup from summer and winter releases. Solid lines do not necessarily indicate the actual path of migration.

ound in the summer fishing grounds along the inshore coastal aters.

In order to examine in detail the temperature differences of the ast four winters, we may refer to the observations made during the urveys of the Bureau of Fisheries steamer *Albatross II* during each winter from 1929 to 1932 [5] and by the Woods Hole Oceanographic essel *Atlantis* in the winters of 1933 and 1934. Thanks are due the Woods Hole Oceanographic Institution and members of its staff who kindly made these observations for the United States Bureau f Fisheries.

CHANGES IN TEMPERATURE

The sea bottom of the Atlantic coast from Cape Hatteras to Cape May is a submerged plain 30 to 100 miles broad, gradually sloping rom the shore until a depth of 50 to 100 fathoms is reached. Beyond the 50- to 100-fathom zone there is a more abrupt drop in he ocean bed so that depths of 300 to 400 fathoms are recorded 5

[5] See "Temperature and the southern trawler" by W. C. Neville, Fishing, vol. XII, no. 2, January 1933.

to 10 miles beyond the edge of the plain or shelf. Beyond this is region of still deeper water extending down to the great depths the ocean. In this very deep water, the bottom temperatures a very low the year around. Inshore of this area of cold water is zone of water between the 40- and 150-fathom depths warmed fro surface to bottom by the Gulf Stream throughout the winter. Th there is a narrow band of relatively warm bottom water prese throughout all winters (of which we have record) following in ge eral the 100-fathom line, extending from abreast of Cape Hatter to at least abreast of Cape May and even continuing to abreast Cape Cod and along the southern edge of Georges Bank. In co trast to this band of water which is warm both in winter and summer, the water covering the wide, inshore, submerged pla out to the 40-fathom depth is subject to great seasonal changes f here the temperatures are high in summer, but in winter the wat is chilled to a greater or less degree from surface to bottom.

This chilling takes place from inshore to offshore so that in so winters the fish have been driven farther offshore than in oth winters depending on the amount of cooling that has occurred. F instance, during the several winters preceding and including 193 this chilling cooled the water clear to the bottom over the enti shelf so that the zone of bottom water, warmer than 45° F. w confined to a narrow band lying beyond the 40-fathom line. T result was that the scup, sea bass, and fluke were driven to wat out near the edge of the continental shelf (area *A* in fig. 2) and depths greater than 40 fathoms where the water was 45° F. warmer. In the following winter (1932), however, the inshore sho water did not cool to such low temperatures as in the previous winte and relatively warm water was present over a much greater exte of sea bottom. In that winter the scup, sea bass, and fluke were n driven as far offshore by water colder than 45° F. and the be catches were made in area *B* which was much farther inshore and shoaler water than area *A*. In the next winter (1933), water tem perature conditions were about the same as in the previous wint (1932) and the best fishing was also in about the same locatio area *C*.

In the past winter (1934), there was a combination of the cond tions of the three previous winters. The early part of the seaso (January) the water was relatively warm, resembling 1932 and 193 but the latter part (March) the water was relatively cool, resemblin 1931. Although air temperatures were low in January there ha not been time for any considerable cooling of the water, for the zon having bottom temperatures warmer than 45° F. apparently sti extended over about the same general area as in the previous tw winters (1933 and 1932), and scup, sea bass, and fluke were in th more inshore, shoal region, the best catches being made in about th same location as in 1933 and 1932, area *D*. In February, howeve the continued severely cold weather resulted in a distinct chilling the water so that the fish were driven to more offshore, deeper, an warmer regions beyond the 45- and 50-fathom lines, area *E*. March, as a result of the continued cold weather throughout th previous month and the first part of March, water temperature continued to drop, and scup, sea bass, and fluke were found not onl

rther offshore and in still deeper water but also to the southward. ater temperatures taken in the early part of March indicated that e zone of 45° F. bottom water was confined beyond the 50-fathom ne in the more northerly part of the ground (38° latitude) but exded inshore to about the 25-fathom line in the southern part (36° itude). In the northern area fishing became poorer either because

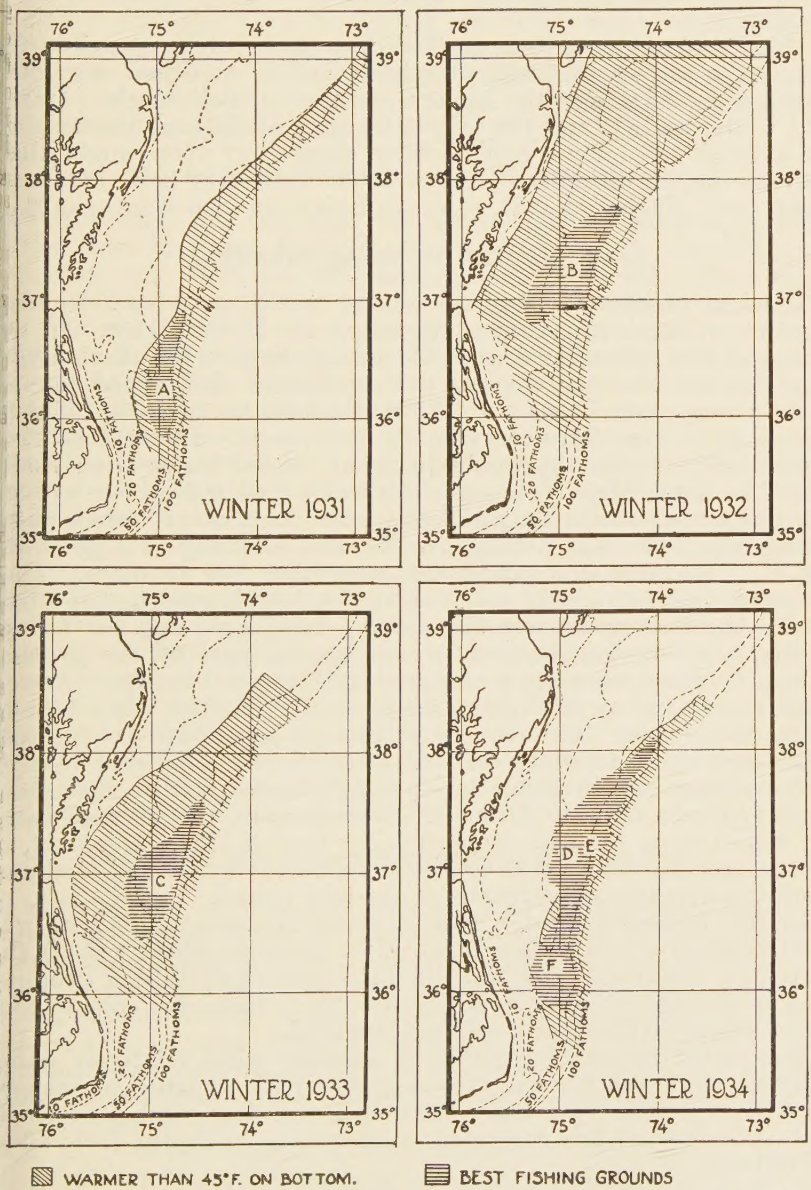

FIGURE 2.—Changes in location of best fishing grounds during the past 4 winters together with changes in position of zone of water warmer than 45° F. on the bottom in late February or early part of March.

the scup, sea bass, and fluke were driven so far offshore and to suc depths that they were beyond the reach of the gear of the majorit of the fleet, or because of migration to the southern area. The fish ing shifted to the southern part of the ground, where the zone c relatively warm water was present over a more inshore and shoale area, area *F*. In March, both the location of fishing and the zone c 45° bottom water approximated the condition existing in the winte of 1931.

These differences in temperatures were not only responsible fo changes in the location of best fishing, but, in addition, were con nected with changes in the amount and kind of fish caught. In th cold winter of 1931 and the cold latter part of 1934, on the basis o the average catch for a day's fishing, more scup were caught tha sea bass; on the other hand, in the warm winters of 1932, 1933, an warm early portion of 1934, more sea bass than scup were caught.

SCUP SCATTER IN WARM WINTERS

The best catches of scup were made in regions where the tem perature of the bottom water was about 45° F. or higher. In th winter of 1931, when the zone of 45° was confined to a rather narrow band far out near the edge of the continental shelf, good catche of scup were made in area *A*. In that winter the majority of scu landed were large fish averaging ¾ to 1 pound. In the following winter (1932) when the vast expanse of coastal water from Bodi Island to Cape May (36° to 39° latitude) had not cooled to such low temperatures as in the previous winter, the zone of bottom wate warmer than 45° was present far inshore, resulting in a great in crease in the area over which the scup were free to move. Tha the scup scattered widely over this region is indicated by the smal catches made at spots over the whole general area and the failur to find the fish concentrated in any special part of the ground Owing to this scattering, it required much harder fishing to catch good fares of scup during the warm winter of 1932 when bottom temperatures were favorable over a greater area than was the case in the previous cold winter of 1931 when the fish were concentrated into a smaller area by being driven some 30 miles farther offshore to depths greater than 40 fathoms. Consequently, the average catch per day's fishing for 1932 dropped below that of 1931. Moreover, in that winter the scup catch consisted mainly of small and medium-sized fish averaging one-fourth to one-half pound.

In the following winter (1933) when the zone of 45° F. was present again over a wide area as in the previous winter (1932) the scup were again scattered and the catch per day's fishing dropped even below that of 1932; as in the previous winter, the catches consisted mainly of small and medium-sized fish.

During the past winter (1934) in January when relatively warm bottom water was present over a rather wide expanse of inshore coastal area, scup were again scattered, and fair catches of small and medium-sized fish were made well inshore in depths from 20 to 25 fathoms.

In February, with the coming of the cold weather and the chilling of the inshore water, the scup were driven more offshore, became more concentrated, and good catches were made in the more offshore

grounds in depths of 40 fathoms or more. By March, when the line of 45° water had again been pushed well offshore to the position it was in the winter of 1931, the scup had again been driven to this region and were in such concentration that good catches were made in the southern part of the ground in depths 30 fathoms or more, area *F* (Fig. 3.). Moreover, the catches in this southern area contained a greater proportion of large-sized fish than was the case in January when the fishing was in the more northerly and inshore area. In addition, in March the average catch for a day's fishing was larger in the southern part of the ground, area *F*, and consisted of a relatively greater number of large fish than in the northernmost part of the ground, area *E* (Fig. 3).

SEA BASS IN WARMER WATER THAN SCUP

The sea bass, like the scup, are driven farther offshore in cold winters than in warm, but because they seek higher temperatures than scup, the effect on the catch is quite different. That they prefer warmer water than scup is shown by the fact that in the last four winters the best catches of sea bass were made in water about 1 to 2 degrees warmer than that in which scup were caught. This preference for warmer water resulted in the sea bass being forced far offshore in the winter of 1931 and the latter part of 1934 (March), and to water so deep that the major portion of the stock must have been beyond the reach of the gear, with the result that less sea bass than scup were caught. In the warm winters of 1932 and 1933, when the warm water extended inshore to the 30-fathom depths, the sea bass could and did remain in this inshore shoal area. They were hence not only more available to the gear, but being restricted to warmer water than the scup, were more concentrated, and because of their greater market value were more sought, yielding on the average a larger catch per trip than did the scup. During the past winter, in January the sea bass were again present in the inshore shoal area in depths from 30 to 40 fathoms but were gradually forced offshore by the chilling of the water in February and March, so that by the latter month the majority were probably as far offshore and in such depths as to be beyond the reach of the gear, as was the case in the cold winter of 1931.

FLUKE IN MORE NORTHERLY PART OF GROUND

The fluke, like sea bass and scup, are also affected by changes in temperature, being driven in cold winters to more offshore, deeper water than in warm winters. The best catches are usually made in somewhat warmer water than scup but not as warm as that in which the sea bass are usually found. The catch has fluctuated about the same as that of scup, although the area of best fishing has been different, being confined largely to the more northern part of the fishing ground, in a southeasterly direction off Cape May, in depths of 40 fathoms or more.

The study of the changes in the abundance of fluke is complicated because of the two different types of trawl nets used (the so-called "flat" net and the "balloon" net). A sufficiently detailed study of the catch records has not yet been made but is necessary in order to determine the causes of changes in the abundance of this fish.

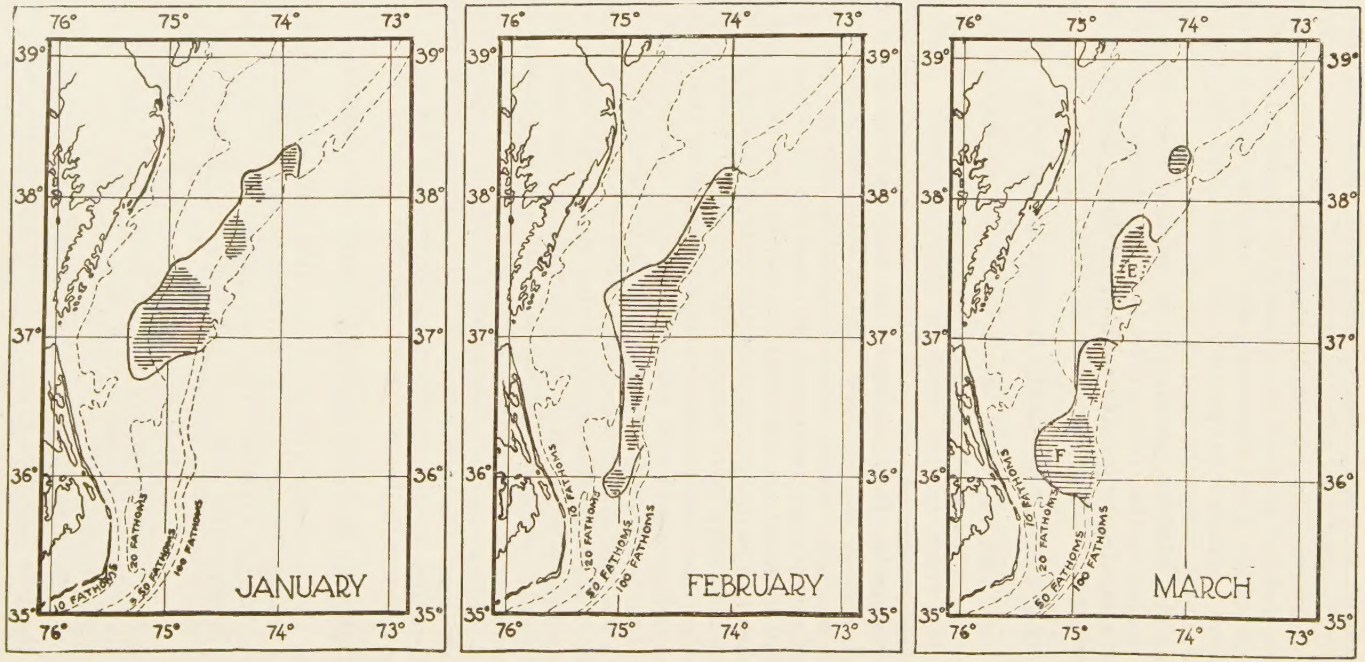

FIGURE 3.—Shift in location of best fishing grounds during winter of 1934.

OUTLOOK FOR THE WINTER OF 1935 (JANUARY–MARCH)

The question as to what might be expected for the winter of 1935 anuary-March) divides itself into two parts: (1) What will be the ndance of the fish; and (2) what will be the effect of tempera- e?

As to abundance, considering the high yields of scup in the summer nery during the past few seasons, especially in the pound-net nery last summer (1934), there is indication that scup, particularly dium-sized fish, will again be numerous in the region of the trawl nery next winter. There is some question as to how abundant sea ss and fluke will be because there has been no opportunity to study e sizes of fish in the summer catches during the past few seasons. As to the effect of temperature, it appears that the location of st fishing and the relative success in catching scup, sea bass, and ke will depend largely on the distribution of the relatively warm ttom water.

It cannot be predicted in advance of the season how much chilling the inshore coastal water there will be and how far offshore the n will be driven, because this depends on general weather, for which ere are no detailed, long-range predictions. The fishermen may, wever, get some idea of what conditions may be expected from the erage air temperature. For instance, if in November and Decem- r the weather is mild, it may be expected that the location of best hing will be more inshore in January than would be the case if ld weather is experienced during November and December.

If the weather continues mild throughout the winter the best hing should be in about the same areas as it was in the warm win- s of 1932 and 1933, with scup scattered over the general fishing ea and sea bass also inshore and more readily caught than scup. , however, the weather is severe throughout the winter, the best hing will undoubtedly be in the southern, offshore region, as in the ld winter of 1931, with more scup than sea bass being caught, the ss being driven farther offshore than scup to the deeper and rmer depths, and, perhaps, in the main beyond the reach of the ar. If, on the other hand, the winter starts out mild and ends up ld, as it did last winter (1934), it might be expected that the fish ll be driven offshore, and the best fishing will shift from an inshore, oal area in the first part of the winter to an offshore, deep, and uthern area by the end of the winter, with more scup than sea bass ing caught in the latter part of the season than in the beginning.

Although in the foregoing discussion we have referred only to e temperature of the water near the bottom, it was found that out the 40-fathom contour the temperature of the water was about e same from top to bottom; beyond that depth the bottom water as consistently about 1° higher than at the surface, and in the ill greater depths (out near the 100-fathom contour) the bottom ater was usually several degrees higher than at the surface. Hence, depths up to 40 fathoms, fishermen may obtain some idea of the mperature of the water at the bottom from surface temperature servations. Some caution should be used, however, following sev- al days of warm weather or a sudden cold spell during which time e temperature of the surface water may have changed considerably ore than the temperature at the bottom. If, however, surface

temperatures are taken regularly and show a sudden rise, it might
assumed that the temperature at the bottom has not changed v
much. Beyond the 40-fathom contour, surface water temperatu
would not be very reliable for indicating the temperatures of
water at the bottom. It does not necessarily follow that if tempe
ture of a certain degree known to be tolerated by the fish is found
a certain spot, that a good catch of fish will be made. The tempe
tures indicate merely the greater possibility of finding fish in t
particular region than in spots where the water may be much cold

CONSERVATION PROBLEMS

The development of the winter fishery has been accompanied
considerable opposition from anglers and from commercial fish
men engaged in the summer fishery for the same species. Oppone
of the fishery criticise it on the following grounds:

1. It imposes an additional strain on stocks of fish believed
many to be overexploited by the summer fishery.

2. The summer fishery is capable of satisfying the public's requi
ments for food fish; consequently, the winter fishery causes ov
production with attendant economic disturbance.

3. The methods of the fishery are wasteful and destructive.

With respect to the first criticism, the Bureau's investigations
the middle Atlantic shore fisheries indicate that the fishery is
taking excessive toll of scup or butterfish. Both species are subj
to marked natural fluctuation in abundance, but both have shown
markable ability to recover naturally from low levels of abundan
Investigations of fluke, sea bass, croakers, and weakfish have
advanced sufficiently to permit judgment as to whether depletion
overfishing is taking place. In accordance with its policy of reco
mending restrictions of fishing only when the need has been dem
strated by adequate scientific investigation, the Bureau does
recommend restriction at this time. It should be pointed out, al
that should further investigation demonstrate overexploitation,
does not follow that the burden of restriction should be bone who
by the winter fishery. Insofar as the methods employed are unobj
tionable, the winter fishery merits neither more nor less considerati
than the summer fishery if restriction be found necessary to prot
future yields.

The second criticism involves economic rather than biological c
siderations. There can be little doubt that the summer fishery h
been unprofitable during the past 3 years. In part, perhaps in lar
part, general economic conditions have been responsible, but it
certain that the difficulties of the summer fishery have been aggr
vated by competition from the winter fishery. Competition has be
felt in three ways: (*a*) Prior to the development of the winter fis
ery, high prices were realized for the early spring catches. T
consuming public, long deprived of fresh fish of the shore varieti
competed actively for the first supplies. At present the consta
supply of fresh shore fish provided during the winter and continui
into the spring depresses the prices realized by inshore fisherm
for spring catches. (*b*) Large supplies of fresh shore fish in t
winter have probably diminished the incentive to freeze surpl
summer production for winter sale, thus decreasing the effectiven

an important economic balance wheel. (*c*) The winter fishery has demonstrated the effectiveness of otter-trawl fishing for certain more species. A number of vessels originally equipped for the winter fishery continue otter trawling through the summer in direct competition with the established summer fishery. Against these losses to the older fishery must be set certain gains. The market for the products of the resource has been extended not only by lengthening the season in which they are available but by their introduction to market areas in Virginia and the Carolinas where scup, sea bass, and fluke were not previously marketed to any great extent. The fishery is carried on to a large extent by vessels which would otherwise be idle during the winter, thus increasing the efficiency of the capital which they represent.

In the third criticism, opponents of the fishery are joined by thoughtful fishermen engaged in the winter fishery. Wasteful and destructive practices are obviously fully as damaging to their own interests as to their competitors. There can be no doubt that objectionable conditions exist. For example, in 1934 it is estimated that of a total catch of approximately 2,400,000 pounds of scup by vessels landing at Virginia ports in January, February, and March, more than 500,000 pounds, or 20 percent, were discarded at sea. Expressed in numbers of fish, it means that of a total catch of approximately 2,700,000 scup, about 1,900,000 fish, or 40 percent, were destroyed and discarded.

These fish consisted in part of fish below the legal limit and in part of small, but legally marketable fish, for which, under the prevailing economic conditions, no market could be found. Because of incomplete records from ports of landing in New York and New Jersey, it is not possible to estimate reliably the numbers of small fish culled from the catches landed at these ports. However, since the smaller sizes of fish are less readily marketable at these ports, it is probable that an even larger proportion of the actual catch of vessels landing at these ports was wasted.

In addition to the considerable quantities of scup actually wasted, there were landed at Virginia ports 242,822 pounds of small scup which brought a gross return to the fishermen of only $1,370.74, at an average price of less than 6/10 of a cent per pound, and 403,699 pounds of small sea bass which brought a gross return of $5,895.47, at an average price of less than 1½ cents per pound.

There can be no question of the desirability of preventing the destruction of the small scup for which no market can be found. Furthermore, it is greatly to be doubted if the present practice of capturing and marketing the smaller sizes of scup and sea bass is profitable in the long run. For example, if by modification of the gear, most of the 242,822 pounds of small scup marketed in 1934 could have been allowed to escape, the total loss of immediate income could not have exceeded $1,370.74. It is known that these small scup would have doubled their weight by 1935, attaining the market classification of medium scup. Since medium scup may be expected to sell at about 5 times the price of small scup, only one-tenth of the small fish allowed to escape in 1934 need be recaptured subsequently in order to recover the slight loss occasioned by allowing them to escape. In the case of small sea bass, the immediate loss would have been greater ($5,895.47). Since the rate of growth of sea bass is

not known, it is not possible to estimate how many of those spare would have to be recaptured later in order to show a profit.

It is virtually certain that changes in the mesh of the cod-ends o the trawls used in the winter fishery would largely eliminate th present waste. Experiments in European and American waters hav shown that the majority of undersized fish can be spared withou loss of marketable fish and without increase in the cost of fishing simply by increasing the size of the cod-end mesh.[6]

The Bureau is not prepared at this time to recommend definit mesh sizes. Considerable experiment will be necessary to determin the correct sizes, for the problem is complicated by the fact tha more than one species must be considered. Lack of funds has pre vented experiments thus far, but it is urgent that they be undertake at the earliest possible date.

[6] "Modifications in gear to curtail the destruction of undersized fish in otter trawling by William C. Herrington. Investigational Report No. 24, U. S. Bureau of Fisheries. I press.

U. S. GOVERNMENT PRINTING OFFICE: 1935

For sale by the Superintendent of Documents, Washington, D. C. - - - - - - Price 5 cent